IMPACT OF WATER HARVESTING STRUCTURES IN WATERSHED DEVELOPMENT PROGRAMME: A CASE STUDY OF ANANTAPUR DISTRICT OF ANDHRA PRADESH

Synopsis

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BANDARU MURALI MOHAN

Research Supervisor

Prof. K.GOVINDAPPA, M.A. M.Phil, Ph.D.

DEPARTMENT OF RURAL DEVELOPMENT AND SOCIAL WORK

SRI KRISHNADEVARAYA UNIVERSITY

ANANTAPUR – 515 003

ANDHRA PRADESH

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Introduction

In the arid and semi-arid regions, precipitation is generally lower than potential evaporation, non-uniform in distribution, resulting in frequent drought periods during the crop growing season and usually comes in intense bursts, resulting in surface run-off and uncontrolled rill and gully erosion. In the cool winter areas, as in the Mediterranean type of climate, precipitation is less than 300 mm, part of which is lost to evaporation and run-off. The amount stored in the root zone is well below crop water requirements. In dry (semi-arid) tropical areas, such as the Sahel zone in Africa, although mean precipitation is relatively higher (500mm), a larger portion of precipitation is lost to evaporation.

A large part of the rainfall returns to the atmosphere directly by evaporation from the soil surface and also a part of that infiltrated into the soil to a small depth evaporates into the atmosphere with no benefits. The part that flows as run-off, if not intercepted, goes to slumps, losing its good quality and evaporating; it may even flow into the sea.

The principle of agricultural rainwater harvesting is based on the concept of depriving part of the land of its share of precipitation, which is usually small and non-productive, and giving it to another part to increase the amount of water available to the latter part, which originally was not sufficient and to bring this amount closer to the crop water requirements so that an economy in agricultural production can be achieved. Such concentration of precipitation in a smaller area is called water harvesting (WH) and may be defined in various ways such as:

Critchley and Siegert (1991) simply define Water Harvest as ‘collection of run-off water for its productive use’. For Reij *et al*. (1988), it is a hydroagronomic term covering a whole range of methods of collecting and concentrating various forms of run-off. The concept of Water Harvest, as described above, is different from the traditional soil and water conservation practices in which no part of the land is purposely deprived of its share of water. Soil-water conservation practices aim at preventing surface run-off and keeping rainwater in place, whereas WH makes use of and even induces surface run-off.

In the water harvesting process the run-off-producing area is adjacent to the cropped area, and part of the land and most of the precipitation water will become productive. More importantly, agricultural production becomes possible and the water harvesting systems might be for a single purpose or for multi-purpose and built to serve domestic, agricultural, animal or environmental uses.

Water harvesting in the past and the present

Ancient and indigenous water harvesting systems exist in many parts of the world and from many eras, such as contour terracing in the central highlands of Mexico; floodwater farming in desert areas of Arizona and northern Mexico, dating back at least 1000 years; and *khadin* systems in Rajasthan, India, initiated probably in the 15th century. One expert gives a brief review of systems found in sub-Saharan Africa, including rock bunds and stone terraces in what is now Burkina Faso and basin systems in Mali; and

Critchley and Siegert (1991) describe the ‘caag’ system in the Hiraan region of Central Somalia.

There are a dozen different classifications of water harvesting techniques, and the terminology of water harvest used at the regional and international levels has not yet been standardized. The geometric configuration of WH systems depends upon the topography, the type of catchment treatment, the intended use and personal preference. Water-harvesting techniques may be grouped into two categories. First, techniques that directly supply run-off water from a small catchment to the crop and thus water accumulate around the plant, infiltrates into the soil and is stored in the crop root zone.

These are called micro catchment techniques, because the run-off-yielding catchments are usually small and directly adjacent to the targeted crop. The other category is macro catchment techniques, which concentrate rainwater run-off flowing in an ephemeral *wadi* (natural channel) and store it in a prepared storage facility (such as a reservoir) for subsequent beneficial use. This category also includes macro catchment techniques in which water is diverted (by proper damming or cross-structure) out of the *wadi* course to inundate nearby lands.

Water Harvesting Through Watershed Programme

In India, watershed management is an important rural development strategy, particularly in rain fed areas characterized by low-productivity in agriculture, degraded natural resources and widespread poverty. A watershed is a geographical area, which drains into a common point, and where soil and

moisture is conserved *in situ*. While watershed development has been implemented since before independence, interest in this area has grown in recent years. Millions of people depend on fragile agriculture and natural resources and there is a huge demand for techniques that can lead to sustainable management of land and water. In such a context, watershed development has become quite necessary. The process of collecting natural precipitation from prepared watersheds for beneficiary use.

- ♣ Collecting and concentrating various forms of run-off from precipitation and for various purposes.
- ♣ The process of concentrating precipitation through run-off and storing it for beneficial use.

Review of Literature

Srinivasa (1988) found that the investment made on water harvesting structures in Chitravati watershed area was economically viable. The productivity of land in terms of yield per hectare increased by 66.79 per cent in ragi, 64.56 per cent in paddy and 98.56 per cent in groundnut due to *nala bund.* Similarly, as an impact of farm pond, groundnut yield increased by 94.44 per cent followed by ragi (73.42%) and paddy (66.66%) yields.

Prabhakar *et al.* (1991) observed that thematic maps so prepared facilitate in planning of different soil and water conservation measures like laying water harvesting structures in the watershed.

D.Narsimha Reddy (1992) in his research noted that on “Decline of Traditional water harvesting systems Tanks in the Drought prone Areas of Andhra Pradesh” given by B.C.Barah and T.Sudhakar outlined the important

traditional water harvesting systems in Drought Prone Aareas. In these areas for ages, the authors look into causes for the decline of tank irrigation. According to the research study the causes are severe financial stringency, rapid increase in the well irrigation and institutional changes. The authors plead that tank irrigation could play an important role as alternate source of water supply to big irrigation projects, multipurpose dams and canals. The paper is concluded by suggestions which include the early completion of the restoration of all the tanks in the state which would enable regular maintenance and repair of the tanks as per the standards specified, rising of bounds and waste weirs to recover the capacity lost due to silting, desalting cum-reclamation to reduce the area submerged and evaporation losses checking of weed growth in the tank bed to reduce transpiration losses and regulation of foreshore and tank bed cultivation as well as afforestation and soil conservation of foreshore areas to minimize sitting up. Finally the authors observe that the tank irrigation systems perform extremely useful ecological functions. The function of conservation and recharging of ground water table are the indirect but beneficial functions of tank irrigation.

Decisions regarding the use of land and water resources of a backward region depend mostly on their productive potential and local priorities. As integrated approach requires information about the topographic and terrain parameters, geomorphic process, water availability, land capability and socio-economic condition of the inhabitants, a database of Chandragiri watershed, Korapur district was generated by Mohanthy *et al.* (1994). The action plans prepared suggest alternate land use plan and sites for water harvesting structures, dug wells and tube wells.

Land use/land cover, soil, hydro-geomorphology, drainage, slope and transportation network maps were integrated spatially by Uday Raj *et al.* (1995) to arrive at composite mapping units which are unique combination of various resources. This action plan comprising alternative land use practices and a comprehensive plan for soil conservation and water harvesting structures like check dams, nala bunds, etc., have been suggested to improve the productivity of Hirehalla watershed in Bijapur district.

Remote Sensing based information coupled with ground observations enabled Panigrahi *et al.* (1999) in studying the geomorphic features; land use/land cover pattern, surface drainage, slope and hydrologic characteristics of the watershed. These themes were integrated and water resource management plan was suggested showing sites for digging bore wells, tube wells and water harvesting structures for storage of water and to increase the ground water potential of the Bajapur Watershed in Orissa.

Chakraborthy *et al.* (2001) have conducted a study in Ballowal - Sounkhri Village in Hoshiarpur district of Punjab, conveyed an approach to water resource management through water harvesting structures. The study infers that if the excess rainwater is stored in the catchment and is conveyed through small channels to the field as per the agriculture requirements in different seasons of the year, it will not only help in attaining self sufficiency in agricultural production, but would also reduce soil loss and recharge aquifers.

Field experiments were conducted by Jain and Kothari (2001) at ARS, Bhilwara, Rajasthan to evaluate the efficiency of recycling of harvested rainwater for rainfed crops. The study revealed that maximum water use

efficiency of harvested water can be obtained by applying it in post monsoon period as partial irrigation to long duration crops in an intercropping system for improving crop production in dry land areas of Rajasthan.

The study of N. Balasubramanyam (2006) investigated the possibility of using harvested rainwater as a source of drinking water without causing any health risk. This can be achieved by adopting suitable storage technique efficient and economical treatment methods. Roof harvested rainwater samples were collected from five different places of Bangalore during October 2005. The water samples were collected and stored in good grade plastic containers and were subjected to periodical treatments (like chlorination, solar disinfections and use of silver nitrate) and tests and use of silver nitrate and tests for physical chemical and Biological parameters up to May 2006.

A.K. Jain', M. Gopinath Reddy and M.S. Rama Mohan Rao (2011) in their article on "Organisational Structure Involving Community for Effective Watershed Development" considers that the evaluation of watershed development projects time and again revealed that the development to be sustainable, calls for involvement of beneficiaries at all stages of development process so as to transform them as Self-Managers. The existing approaches in developing three watersheds under similar agro-climatic and socio-economic conditions, developed by research, development and NGO agencies were assessed to identify an appropriate organisational structure for developing watersheds on a sustainable basis keeping productivity, conservation, livelihoods and equity concerns in harmony. The longitudinal approach (before and after situation) was adopted to measure the impact. The

study reveals that the people's involvement was better in NGO managed watershed due to formation of affinity groups such as Self Help Groups (SHGs) and User Groups (UGs) which remained active even after completion of the programme. The study has established the need for strengthening focal level institution, by creating suitable institution at the district level, with capacities and capabilities in managing resources on long term basis for improving productivity and ensuring livelihoods to the rural communities. Strengthening local level institution with support from UGs formed at the village level to conserve and manage the resources related to crop production, livestock, water use and managing common properties would lead to sustainable development by transforming every individual as a partner of the programme. It is concluded that for sustainable development of watersheds, involvement of local level institutions supported by affinity groups and guided by technical persons at different levels on continuous basis was needed. Then alone the primary stakeholders can transform into self-managers. The study also observed that water harvesting structures created through watershed development programmes are better managed with the support and participation of NGOs. It is an important for long lasting of the structures.

Statement of Problem

Water Harvesting (WH) Soil and Water Conservation (SWC) in croplands and on pasture hold the potential to contribute to the vital wider development of dry lands pasture by increasing the yields and their reliability. If well planned, successful water harvesting and soil water conservation initiatives can create the conditions required to enable local land users (small

holders, agro-pastoralists and pastoralists) to escape from the vicious cycles that lead to land degradation and rural poverty, by contributing to poverty reduction and economic growth. However, there are potential negative trade-offs associated with increased agricultural water use, which should be anticipated and plans made to limit potentially deleterious impacts. Watersheds (river basins) have long been acknowledged as the appropriate and logical unit of analysis and planning for improving water resources. Through watershed management, it has been proven that soils and water (surface and ground) resources can be better managed and sustained using SWC techniques.

The watershed approach encourages the promotion of co-operation between upstream and downstream stakeholders – in an effort to minimize conflicts over land and water. Plans must make sense both economically and environmentally – to contribute for poverty reduction and improve the functioning of the watersheds – particularly to restore the recent widespread reduction in groundwater levels in semi-arid areas. The watershed approach also provides clarity in determining the economic importance of water-related ecosystem service (e.g. increasing water yield, improving water quality, reducing sediment delivery to a reservoir). The approach can be used at a range of spatial scales, from micro-catchments upwards.

Study Area

The study area is Anantapur district located in one of the most drought-prone districts of Rayalaseema region of Andhra Pradesh. The main focus in the study area is on the Watershed Development Programme implemented by

District Water Management Agency (DWMA) and the NGOs. While India is considered to be rich in annual rainfall and total water resources, water is spatially and temporally unevenly distributed. Andhra Pradesh is one of the states with less-than-average rainfall, while within the state, Anantapur district is registered as the least annual average rainfall of 540 mm. The area is one of undulating topography, poor soils and a generally low resource base. Over the years population pressure has added to the problems of this region characterized by high fragility and low carrying capacity. Moreover, of late, rainfall has become more erratic with its distribution, becoming unfavorable for crop calendars. Though average rainfall over the last 100 years appears to be stable or increasing, rainfall in the crucial months like July (showing of groundnut which is typical crop) has declined. Its geographical disadvantage provides little scope for surface irrigation facilities. As a result, Anantapur has the lowest proportion of area under irrigation **(**12.6**%)** in the state.

Anantapur district accounts for 4.78 per cent of the state's population and 6.95 per cent of the geographical area. It has only 10.30 percent of its area under forests as against 22.6 percent at the state average. Anantapur district has a higher percentage of marginal (34.45%) and semi small -sized (31.67%) farms, compared with state averages. About 17.63 per cent of its population belongs to Scheduled Castes (SCs) and Scheduled Tribes (STs), which are lower than the state average. Its sex ratio (977/1,000) is lower than the state average of 992 per 1000 male. However, the sex ratio has increased from 958 to 992 during the last decade. The incidence of gender discrimination is expected to be relatively more acute here because of its low level of development.

The district has a literacy rate (64.28%) below the state average (67.66%) as per 2011 provisional population statistics. The figures are much lower in the case of female literacy with 54.31per cent as against the state average of 59.74 per cent. As far as basic services are concerned, 57.64 per cent of Anantapur villages have no access to safe drinking water. In fact, most of the habitations are reported to have poor quality water. About 62 per cent of the villages in the district have access to post and telegraph facilities. Transport-worthy roads or all-weather roads are connected to 68.73 per cent of the villages in the district. All the villages have access to electricity. Different types of watershed treatment activities are carried out in Anantapur district to harvest water activities such as soil and moisture conservation measures are undertaken in private agricultural lands (e.g. contour/ field bunding, land leveling, and summer ploughing). Village common lands are improved through drainage line treatment measures (loose boulder check dams, minor and major check dams and retaining walls), water resource development/management (percolation pond, cattle ponds and renovation of tanks), and afforestation programmes. Training in watershed technologies and related skills are also given periodically to farmers in watersheds. In addition, members are also exposed to other successful watershed models and research institutes for exposure. These efforts appear to be contributing in creation of large number of water harvesting structures to improve ground water re-charge.

Objectives of the Study

Though the general objective of the study is to assess the impact of water harvesting structures in watershed development programme in

Anantapur district. The specific objectives of the study are as follows.

1. To know the importance of water harvesting structures in watershed development programme.
2. To discuss the origin and growth of watershed development programme with special reference to water harvesting structures.
3. To understand the different methods of water harvesting structures in watershed development programme.
4. To understand the socio-economic profiles of the sample farmers and sample watershed villages.
5. To analyze the impact of water harvesting structures promoted under watershed development programme on sample beneficiary farmers.
6. To suggest the measures for creation of effective and sustainable water harvesting structures suitable for drought prone regions.

Sample Design

For a detailed study, Anantapur district is selected as universe. The district is divided into three revenue divisions viz., Anantapur, Dharmavaram and Penukonda. In all these three divisions there are 63 revenue mandals. As on 31st March 2012, there are 723 ongoing watersheds in Anantapur district, covering three revenue divisions of the district. So far 2547 watersheds have been completed in the district in different phases. In all these phases water harvesting activities have been taken up in almost all watersheds. For the present study the watersheds which are completed during March 2001 to March 2011 are selected.

For selecting the sample from the universe for this study, stratified and purposive sampling technique was adopted in selecting the mandals, villages

and the watersheds. Proper care is taken to cover all aspects of watersheds in general water harvesting structures in particular. The general features of the sample villages, watersheds and sample farmers are reflecting the general features of the universe were selected. Initially two revenue mandals from each revenue divisions were selected. In these mandals, two completed watersheds were selected by following stratified sampling technique. From six mandals 12 watersheds have been selected by following purposive sampling technique to select the watersheds where more number of water harvesting structures have been created. From each watershed 30 downstream farmers were selected. Finally, altogether three revenue divisions, six revenue mandals, 12 watersheds (one watershed from each village) and 360 beneficiary farmers were selected. Thus, the total universe for the study constitutes 360 respondents. Proper care was also taken to cover cross sections of the beneficiaries. The Table1.1 clearly depicts the sample details.

Table 1.1

Total Sample Universe for the Study

S.NO	Name of Revenue Division	Name of the Mandal	No. of Watershed	No. of Farmers
1	Anantapur	1.Rapthadu	1.Ayyavaripalli	30
			2.Gangalakunta	30
		2.Atmakur	3. Madigubba	30
			4.D.K. Tahnda	30
2	Dharmavaram	1.Bathalapalli	5.Garisanapalli	30
			6.Edula Mustur	30
		2. Dharmavaram	7.Thanakantivaripalli	30
			8.Elukuntla	30
3	Penukonda	1.Somandepalli	9.Velidadakala	30
			10.Julukunta	30
		2. Penukonda	11.Venkatapuram	30
			12.Yerramanchi	30
Total	**3**	**6**	**12**	**360**

Methodology

To examine the objectives of this study, relevant data were collected from both primary and secondary sources. Field Survey was undertaken for collection of primary data. For this purpose, a pre-tested interview schedule was employed. Further, observation technique was followed to understand certain aspects of the problem. The field survey was conducted in March-April 2012. The data collected from the sample beneficiaries relating to the particulars of water harvesting structures in the watershed, type of water harvesting structures, crops, water yield, crop yield, employment generation etc. The information collected in the field was confirmed with the DWMA records/ledgers and the latter for analysis.

Besides, secondary data regarding the growth of watersheds in India , in Andhra Pradesh and Anantapur were collected from different published records which include reports of the Department of Land Resources and

reports of the Department of Rural Development, Government of India, Andhra Pradesh, reports of NABARD, annual reports and records of DWMA Anantapur, records of selected Mandal Praja Parishads, Statistical Abstracts of Government of Andhra Pradesh and Hand Book of Statistics, Anantapur District etc.

Statistical techniques used

The collected data were processed, tabulated and calculated with the help of computer techniques. The data were analysed and discussed with the help of averages, percentages, statistical tools such as weighted averages, Qui Squares, correlation etc.. The data were also presented with the help of appropriate bar and pie diagrams.

Reference Period

The study is confined to the watersheds which have been completed during March 2001 to March 2011.

Chapter Scheme

The Thesis has been divided into Six Chapters.

Chapter-I	**:**	**Introduction and Research Design**
		Discussion on the history of water harvesting methods, significance of water harvesting structures and also contains theoretical and methodological frame work of the study.
Chapter-II	**:**	**Review of Literature**
		Contains review of literature on watershed development programme and water harvesting techniques.
Chapter-III	**:**	**Watershed Development Programme in India Andhra Pradesh and Anantapur District : An Overview**
		Origin and growth of watershed development programme, various watershed development schemes, and policies at national, state and district level.
Chapter-IV	**:**	**Agronomic and Water Profile of the Study Area and Socio-Economic Profiles of the Sample Respondents**
		The details of agronomic and economic profile of Anantapur district and also discuss the socio-economic profile of the selected sample watersheds and sample respondents.
Chapter-V	**:**	**Empirical Evaluation of the Impact of Water Harvesting Structures on Sample Farmers**
		The views of sample farmers on water harvesting structures.
Chapter-VI		**Summary, Findings and Policy Implications**
		Summarizes the whole study, discusses the major findings and policy implications and suggestions.

Limitations of the Study

The present study is district specific, target specific as well as time specific. The secondary data was collected and presented covering 10 years of period only. Because of the time and financial constraints, the study has been confined to six Mandals, 12 watersheds and 360 beneficiaries. Besides, the responses given by the selected respondents to the questions framed for the study were the main basis for drawing the inferences. Despite the care and caution taken by the researcher, the respondents due to their illiteracy and ignorance might not responded properly in the sense as expected by the researcher. Therefore, the findings are subject to this reality.

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